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# GALLIUM, ITS PROPERTIES AND MELTING POINT

# GALIUM, JEHO VLASTNOSTI A BOD TAVENÍ

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***Abstract***

This paper deals with properites and melting point of gallium. We performed the research aimed on reduction of the uncertainties when we realized the defining fixed point of gallium in accordance with ITS-90. Material of crucible for the melting of gallium was teflon. Crucible was filled up with the gallium of purity 99.99999 %. We examined the effect of thermal condition of the melting on the temperature and shape of melting plateau. In this first step we created only outer liquid-solid interface.

***Abstrakt***

Tento článek se zabývá vlastnostmi a bodem tavení galia. Vykonali sme výskum zameřený na redukci nejistot, když sme zrealizovali definiční pevní bod galia v soulade s ITS-90. Materiál banek pro tavení galia byl Teflon. Banky byli plnené galiom čistoty 99,99999%. Vyšetřovali jsme vplyv tepelních podmínek tavení na teplotu a sklon zádržné čáry. V prvním kroku jsme vytvořili jen vonkajši rozhraní kapalina - tuhá fáze.

***Key words:*** gallium, properties, melting point

## 1. Introduction

Gallium is the metal with very low temperature of melting. Its melting point is 29.7646 °C. Gallium is the metal, which can by used as a definition fixed point. The atomic weight of gallium is 69,723 g·mol-1. Its boiling temperature is 2420 °C, even though with a certain uncertainty, due to gallium reactivity with the material of the container at this temperature [1]. Defining fixed points produce the temperature scale. Temperature scale is realized by means of document ITS-90, what is the internationally accepted document allowing the realization of temperature scale. We used to realization of gallium melting point gallium with 99.99999 % purity. A sample of this purity allows one to achieve an exceptionally stable melting point [2]. This paper presents the construction design of the new gallium cells and the results of performed experiments.

## 2. Principles of solution

Gallium used in this experiment was very pure with minimal contamination. Gallium cells were filled with high pure gallium (99.99999%). Because gallium has a large expansion at solidification (3.1 %) makes it desirable to use a slightly flexible construction of the cell, therefore the crucible is made of Teflon. (Fig.1) represented the design of gallium cell. On the (Fig.2) is the photo of the cells. Teflon is highly plastic, does not interact with the metal and it ensures the cell tightness. The thermometer well is made together with the cap as a single piece. In the cap assembly a provision was made for an outlet to evacuate and fill the cell with gas at a present pressure as it is described in [3].

All parts of the cell that are in direct contact with gallium were carefully cleaned before the cell filling, because they could be contaminated.

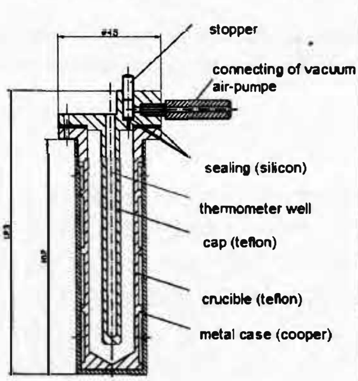



**Fig. 1** Design of the miniature gallium cell for adding the impurities

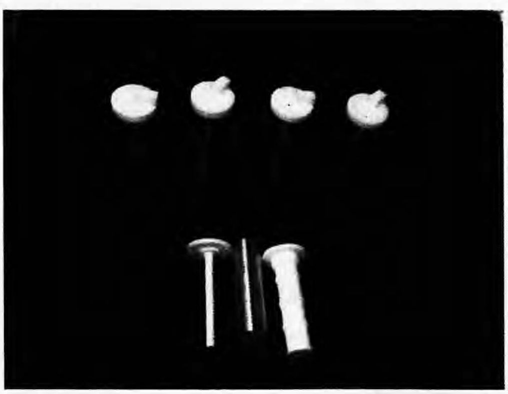


**Fig. 2** Photo of the miniature gallium cells for adding the impurities

The cells were filled in glove boxes (Fig.3) under protecting atmosphere of argon during all filling of the cell with gallium.

We realized the melting point of gallium in stirred liquid bath. Temperature of the bath was set initially on 28.7 °C. After the stabilization, temperature of the bath was increased on the temperature 5 °C above the melting temperature and plateau was observed. Similar experiments were performed when bath temperature was 3°C, 1°C, 0.5 °C above the melting. Plateau was monitored by standard platinum resistance thermometer (SPRT) with the nominal resistance 25 Ω. The resistance of the SPRT was measured by means of AC resistance bridge. Stability of thermometer was checked by its measurement at the triple point of water.

Graph.1 shows melting curves, when the temperature of the bath was 5°C and Graph 2 shows melting curves when the temperature is 3 °C above the melting temperature.

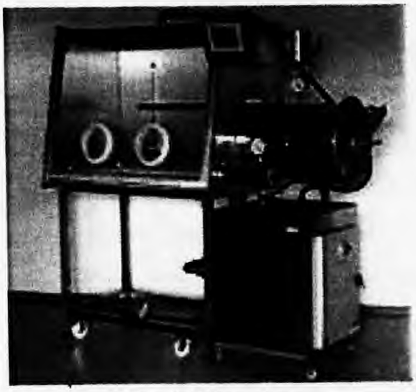
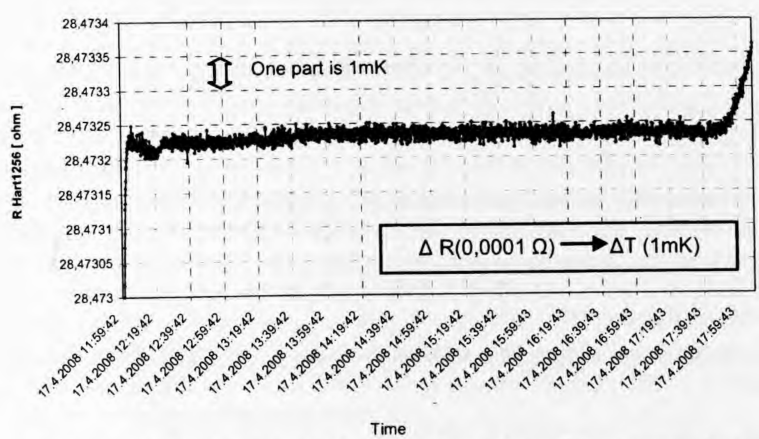
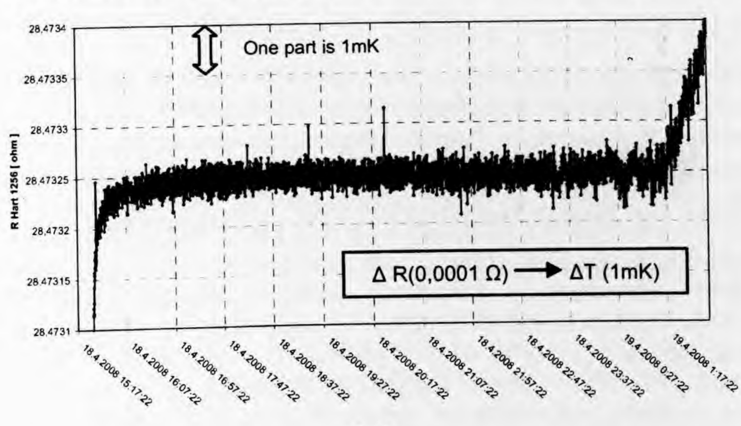


**Fig. 3** Glove-box




**Graph 1** The melting curve by 5 °C above the melting temperature




**Graph 2** The melting curve by 3 °C above the melting temperature

Our performed experiments were realized for determination of the influence of the thermal condition on temperature and the phase transition of gallium. Duration of the plateau at various temperature of the bath is presented at Tab.1 Experiments oriented on study of influence of impurities will be performed by means of miniature cells (Fig. 1) which will be filled with gallium contained known quantity of specified impurities.

**Table 1** Duration of the plateau at various set temperatures

| **The set temperature of the bath** | **Duration of the plateau (within 0,3 mK)** |
|---|---|
| 5 °C | 6 hours |
| 3 °C | 9 hours |
| 1 °C | 32 hours |
| 0.5 °C | 75 hours |

## 3. Conclusion

Two primary gallium fixed point cells has been developed and build with the corporation Faculty of industrial technologies and Slovak Metrological Institute in Bratislava. Up to now a few experiments was performed. Experiments were performed to study the effect of thermal conditions of realization on the phase transition temperature and the shape of the melting plateau.

We examined the effect of thermal condition of the melting on the temperature and shape of melting plateau. In this first step we created only outer liquid-solid interface. In the second step we will create also the inner liquid-solid interface. In the following step of research we plane to observe influence of two specified impurities on melting and freezing of gallium. On the base of our results it seems, that thermal conditions have effect not only on the shape of the plateau, but also on its position. It is is necessary to perform a lot of addition experiments for verification performed experiments


## Acknowledgement

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